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Targeting of Convoy Vehicles is Not Disrupted by a Green Laser: Moving, Predictable Targets in Bright Lighting

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14. ABSTRACT <b>Protecting military convoys from sniper fire is a priority. A fielded green laser was evaluated for its capacity to interfere with the ability of a shooter to hit moving outdoor targets, both while the laser was on and again just after termination. We tested each subject's ability to locate, identify, and hit a target using rifle-like armaments, during trials with or without laser exposure. Impairment was defined as fewer target hits during laser trials, compared to no-laser trials. Two trucks traveling in a convoy served as targets. Eight subjects shot during 14 trials. On laser-exposure trials, Target 1 was presented concurrently with the laser, and Target 2 was presented immediately after removal of both Target 1 and the laser. Target 1 &amp; 2 accuracy on laser trials did not differ from no-laser trials. On non-exposure trials, no target accuracies differed. Shooter skill did not affect impairment. Under bright lighting conditions, shooting at moving (but predictable from extrapolation), brief-exposure targets, the maximum eye-safe green laser exposure did not impair targeting success while on the shooters eyes nor afterward. Perceptual mechanism and situational contributors to effectiveness are discussed.</b>					
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# The Problem



- Protecting military convoys from sniper fire is a priority.
- Soldiers would like to use non-injurious lasers in civilian settings to impair potential shooters to keep convoys safe.



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# Specific Objectives



- Determine effectiveness of a green laser under eye-safe conditions against the ability of a shooter to hit a target.
- Test laser effectiveness
  - during laser exposure
  - immediately after laser exposure.



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# General Method



- Test human volunteers
  - shooting outdoors
  - under daytime lighting
  - at moving convoy vehicles
- Compare shooting accuracy
  - laser-exposure trials vs. non-laser trials



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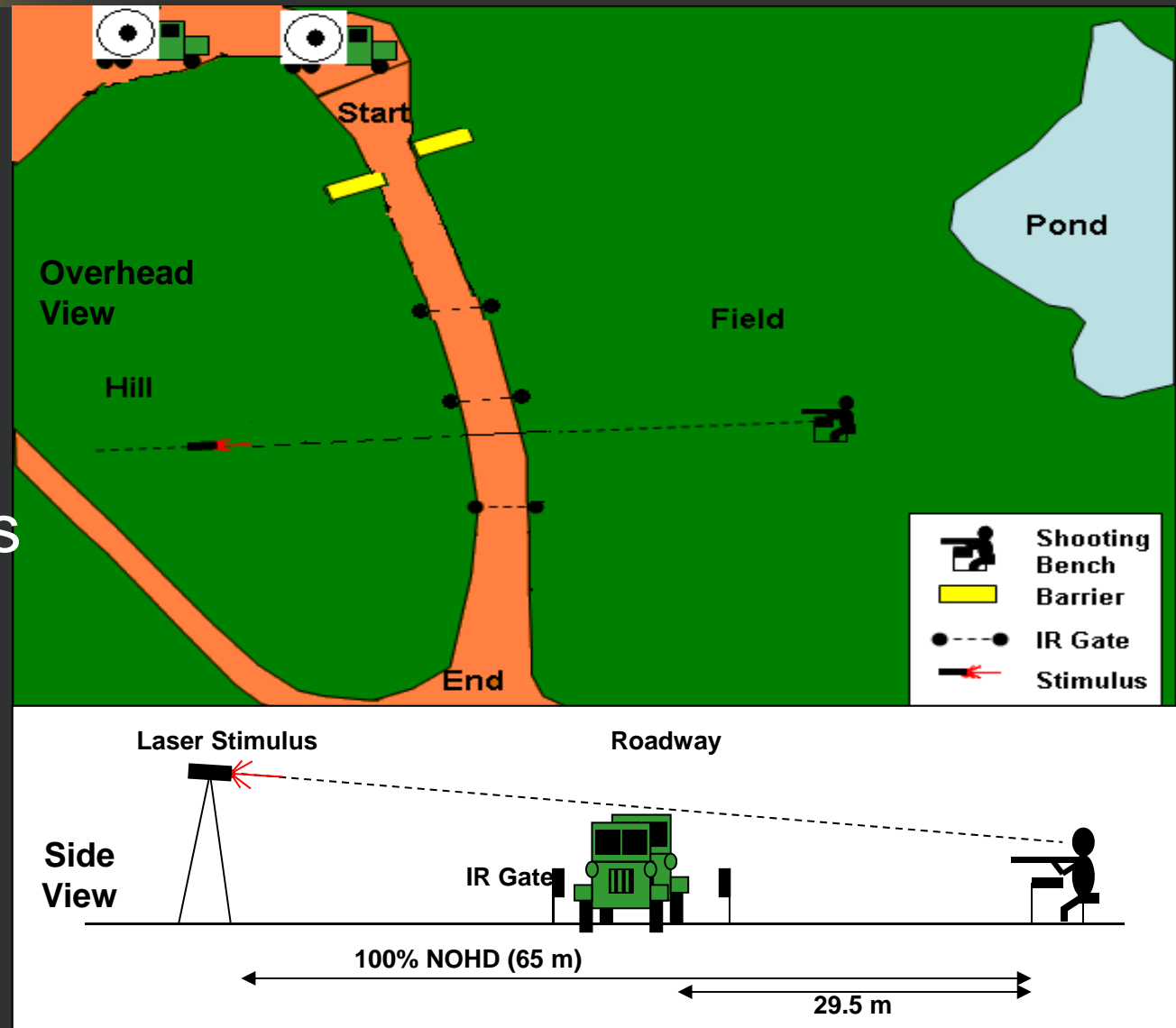


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# Convoy Test-Bed Layout



- Laser shines over trucks, across road to shooter
- Two convoy trucks serve as targets
- Each target is available for ~1.4 sec



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# The Laser



- B.E. Meyers GBDIII-C Laser



- Laser shone on shooter's face on some trials

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# Convoy Targets in Range

- Shooter view
- Truck targets closely spaced
  - 1.4 sec apart
- Laser on tripod above Target 1
  - Sitting on parked truck
  - Shines over first target



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# Convoy Targeting Area



- Convoy targets are visible upon approach
- Shots allowed when targets are between white reflector posts
- Pink dot on forward truck's target: Hit



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# Experiment Method



- 8 healthy subjects with good eyesight participated as shooters
  - Subjects were trained to criterion on shooting task with an FN-303 less-lethal launcher
  - On each trial, subjects shot at targets mounted on two moving convoy vehicles
  - Trucks were closely following one another



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# Experiment Method



- Experiment consisted of 14 trials consisting of two targeting opportunities each, for 28 total targeting opportunities.
  - 7 of the 14 trials began with laser exposure during Target 1 presentation; no laser was presented during the other 7 trials
  - For each laser trial, a subject was exposed to the laser for the duration that the first target was in range and available to be hit.
  - The laser appeared to originate from immediately above Target 1 (0.5° visual angle)
  - When the first target had passed, the laser was terminated simultaneously and immediately the second target was available to be hit.



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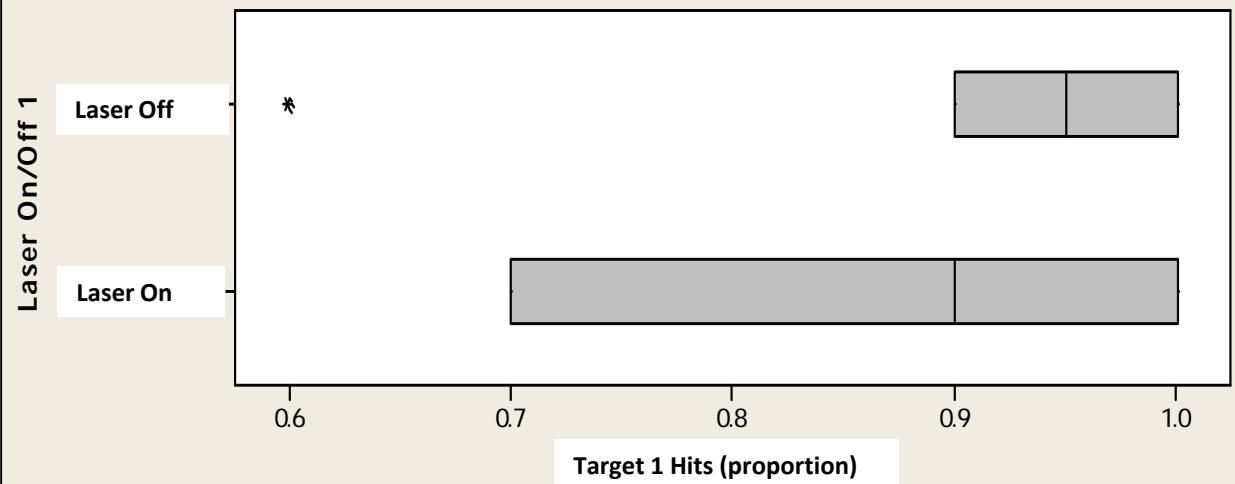


# The Results

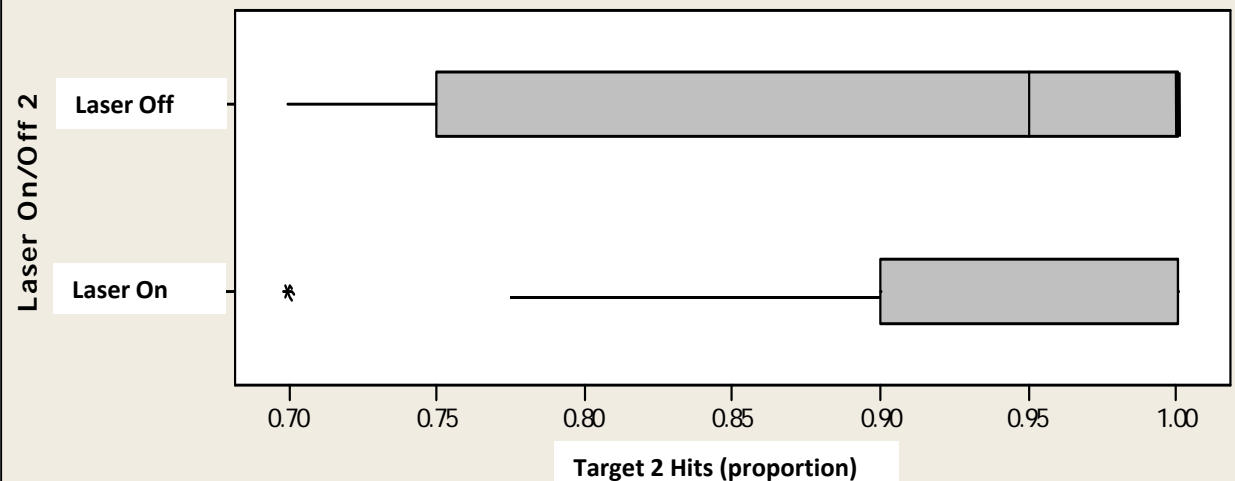


- Medians and quartile boundaries for hit rates
- On laser-exposure and non-exposure trials
- For the first target (top plot) and second target (bottom plot) in each

Boxplot of Hit 1 vs Laser On/Off 1



Boxplot of Hit 2 vs Laser On/Off 2



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# Results: During Laser



## Shooting While Laser Is On Eyes:

### Question:

Does the laser interfere with hitting the target while it is on the eyes?

### Findings:

- Hit percentages for Target 1 when laser was on did *not* differ from hit percentages when laser was off.
  - 95% vs. 90% difference was not reliable
  - [Kruskal-Wallis test  $H_{1,15} = 0.45$ ,  $p = .502$ ]







# Results: After Laser



## Shooting After Laser is Turned Off:

### Question:

Does the laser cause residual interference with targeting after it ends?

### Findings:

- Hit percentages after the laser did not differ from no-laser trials. There is no residual effect.
  - 95% vs. 100% difference was not reliable
  - [Kruskal-Wallis test  $H_{1,15} = 0.34$ ,  $p = .558$ ]







# Results: Task Difficulty



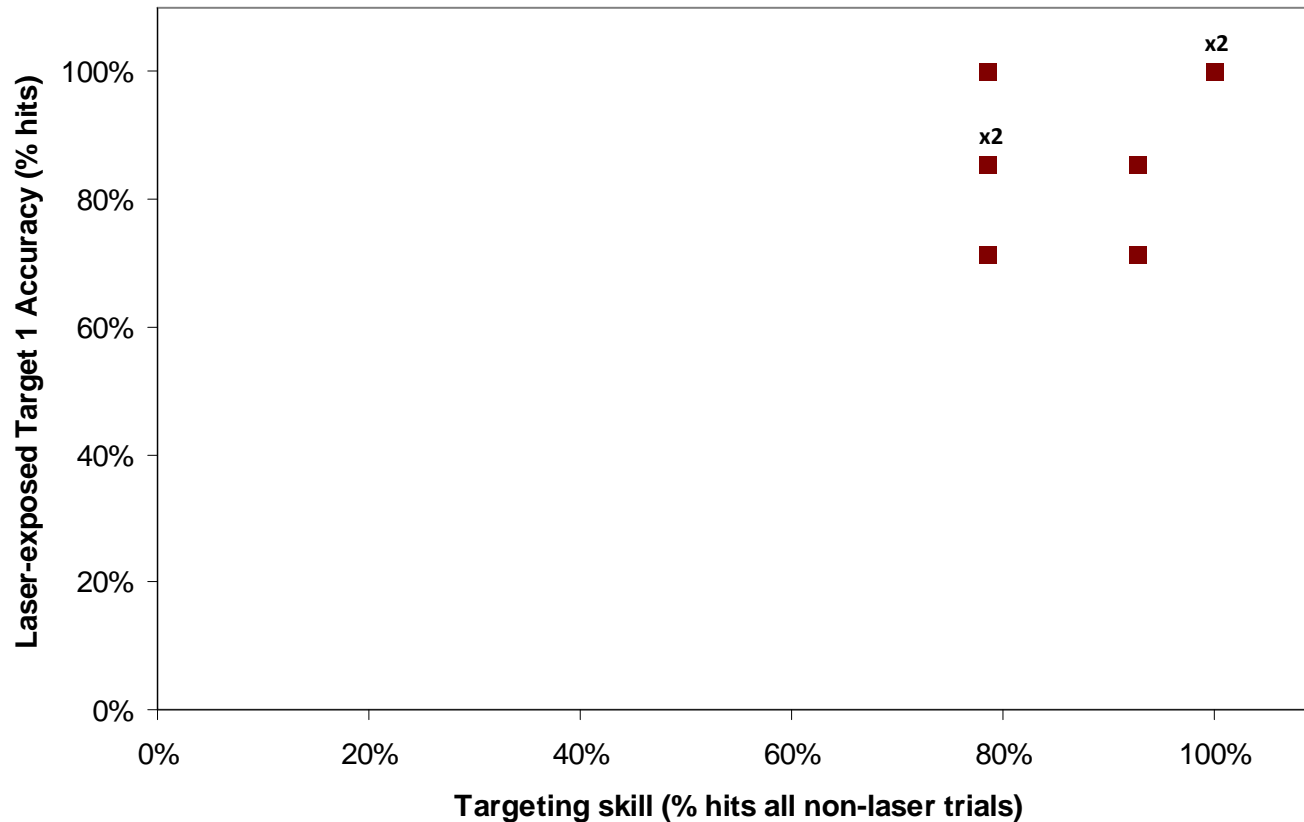
- On non-exposure trials:
  - Targeting success for the first target and the second target were identical (95% hits).
  - Suggests that the difficulty of the two targeting tasks was similar.
  - Any difference in targeting accuracy between the two targets on the laser-exposure trials cannot be attributed to differential difficulty.



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# Results: Shooting skill



- Skill was not related to laser effectiveness
  - predicted less than 6% ( $R^2=.056$ ) of the variance



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# Discussion: Predictability



- Predictability of the target location may have kept the laser from interfering with targeting.
  - Trucks moving at constant speed could be anticipated prior to laser onset.
  - In another experiment (Short et al., 2007), static targets were presented for a similar duration but in an unpredictable manner, and the same green laser was highly effective



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# Discussion: Ambient Light



- Alternatively, the relevant feature may be high level of ambient light during task
  - Therefore laser had low temporal contrast
  - Light-acclimated ( $2782 \text{ lux} \pm 306 \text{ SEM}$ ) subjects would have low sensitivity
  - Same laser was highly effective in dim light, laboratory targeting test (Short et al., 2007)



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